Text to Accompany:

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1979

COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE NORTHWEST QUARTER OF THE CITADEL PLATEAU 15-MINUTE QUADRANGLE, MOFFAT COUNTY, COLORADO

[Report includes 3 plates]

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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Purpose

This text is to be used in conjunction with Coal Resource Occurrence and Coal Development Potential Maps of the northwest quarter of the Citadel Plateau 15-minute quadrangle, Moffat County, Colorado. This report was compiled to support the land planning work of the Bureau of Land Management (BLM) and to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) in the western United States. This investigation was undertaken by Dames & Moore, Denver, Colorado, at the request of the U.S. Geological Survey under contract number 14-08-0001-15789. The resource information gathered for this report is in response to the Federal Coal Leasing Amendments Act of 1975 (P.L. 94-377). Published and unpublished public information available through February, 1979, was used as the data base for this study. No new drilling or field mapping was performed as part of this study, nor was any confidential data used.

Location

In this report, the term "quadrangle" refers only to the northwest quarter of the Citadel Plateau 15-minute quadrangle which is located in south-central Moffat County in northwestern Colorado, approximately 33 airline miles (53 km) northwest of the town of Meeker and approximately 31 airline miles (50 km) west of the town of Craig. The quadrangle is unpopulated.

Accessibility

U.S. Highway 40 crosses from the northeastern corner of the quadrangle to the west-central edge, connecting the towns of Maybell and Cross Mountain. Three improved light-duty roads pass through the southern part of the quadrangle along Cedar Springs Draw, Freeman Gulch and Deception Creek. The remainder of the quadrangle is accessible by numerous unimproved dirt roads.

Railway service is provided by the Denver and Rio Grande Western Railroad from Denver to the railhead at Craig approximately 31 airline miles (50 km) east of the quadrangle. The rail line is the major transportation route for coal shipped east from northwestern Colorado (U.S. Bureau of Land Management, 1977).

Physiography

The northwest quarter of the Citadel Plateau 15-minute quadrangle lies at the western edge of the Southern Rocky Mountain physiographic province, as defined by Howard and Williams (1972), and is approximately 80 miles (129 km) west of the Continental Divide.

The landscape within the quadrangle is characterized by broad gentle slopes in the northern two thirds of the quadrangle and steeper slopes and narrower canyons in the southern third of the quadrangle. Altitudes range from approximately 7,240 feet (2,207 m) on the northern part of Wolf Mountain in the southeastern part of the quadrangle to less than 6,040 feet (1,841 m) in the northwestern corner. Cedar Knob rises approximately 500 feet (152 m) above Cedar Springs Draw in the southwestern part of the quadrangle.

The southern half of the quadrangle is drained mainly by Cedar Springs Draw and Deception Creek and its tributaries (Jacobs Draw and Freeman Gulch). Both Cedar Springs Draw and Deception Creek empty into the Yampa River north of the quadrangle. Other small tributaries of the Yampa River drain the northern part of the quadrangle. All streams in the quadrangle are intermittent, flowing mainly in response to snowmelt in the spring. Dry Lake Reservoir is located on the east-central edge of the quadrangle.

Climate and Vegetation

The climate of northwestern Colorado is semiarid. Clear, sunny days prevail in the area, with daily temperatures typically varying from 3° to 32° F (-16° to 0° C) in January and from 48° to 88° F (9° to 31° C) in July. Annual precipitation in the area averages approximately 12 inches

(30 cm). Snowfall during the winter months accounts for the major part of the precipitation; however, rainfall from thundershowers during the summer months also contributes to the total. Winds, averaging approximately 3 miles per hour (5 km per hour), are generally from the west, but wind directions and velocities vary greatly depending on the local terrain (U.S. Bureau of Land Management, 1977).

The typical vegetation in the northern and central parts of the quadrangle is mountain shrub with sagebrush in the southern third and along the northern edges of the quadrangle. A small area of grassland occurs along Deception Creek north of Wolf Mountain (U.S. Bureau of Land Management, 1977).

Land Status

The northwest quarter of the Citadel Plateau 15-minute quadrangle lies on the northwestern edge of the Danforth Hills Known Recoverable Coal Resource Area (KRCRA). Only the south-central part of the quadrangle lies within the KRCRA boundary, and the Federal government owns the coal rights for approximately 90 percent of this area as shown on plate 2. There are no active coal leases within the quadrangle.

GENERAL GEOLOGY

Previous Work

The first geologic description of the general area in which this quadrangle is located was reported by Emmons (1877) as part of a Survey of the Fortieth Parallel. The decision to build a railroad into the region stimulated several investigations of coal between 1886 and 1905, including papers by Hewett (1889), Hills (1893), and Storrs (1902). Gale (1910) reported on the coal fields and geology of northwest Colorado and Sears also described the geology of this area in 1925. Relatively little recent work has been done in this quadrangle and surrounding areas. Reheis (1975) compiled a generalized geologic map of the Danforth Hills KRCRA, which includes only the area within and immediately adjacent to the KRCRA boundary. Pipiringos and Rosenlund (1977) prepared a preliminary geologic map of the White Rock quadrangle to the southeast, and Rowley and others (1978) compiled a preliminary geologic map of the Vernal 1° x 2° quadrangle that includes the Citadel Plateau area.

Stratigraphy

The formations cropping out in the mapped (Reheis, 1975) area range in age from Late Cretaceous to Miocene and include the coal-bearing Williams Fork Formation of the Mesaverde Group.

The Mancos Shale crops out in the southeastern corner of the quadrangle (Reheis, 1975) and is composed of gray shale interbedded with thin layers of sandstone and sandy shale near the top (Tweto, 1976). According to Tweto (1976), the Mancos Shale is approximately 5,000 feet (1,524 m) thick in northwestern Colorado. However, its total thickness in this quadrangle is unknown.

The Iles Formation conformably overlies the Mancos Shale and crops out within the KRCRA boundary in the south-central part of the quadrangle. It consists of massive sandstone, interbedded with shaly sandstone, sandy shale, and black carbonaceous shale. To the southeast in the Meeker quadrangle, Hancock and Eby (1930) report that the Iles ranges in thickness from approximately 1,350 to 1,600 feet (411 to 488 m), and it is believed that the formation is probably within that range in this quadrangle. The Trout Creek Sandstone Member caps the formation and consists of about 110 to 120 feet (34 to 37 m) of massive white sandstone with some thin beds of shale and shaly sandstone. Two coal-bearing sequences, the "lower" coal group and Black Diamond coal group (Hancock and Eby, 1930), occur in the Iles below the Trout Creek Sandstone Member in the Meeker area, but these coal groups have not been identified in this quadrangle.

The Williams Fork Formation also crops out within the KRCRA boundary in the south-central part of the quadrangle and is approximately 3,400 feet (1,036 m) thick (Sears, 1925) where measured in Freeman and Bob Hughes (Swan Draw) Gulches just south of the quadrangle boundary in the southwest quarter of the Citadel Plateau 15-minute quadrangle. The formation is generally divided into three units: a lower coal-bearing unit, the Lion Canyon Sandstone Member, and an upper unit that also contains coal. Individual thicknesses of these three units are not known in this quadrangle, but they have been estimated based on geologic data projected from the White Rock quadrangle (Pipiringos and Rosenlund, 1977), and the Devils Hole Gulch area (Hancock and Eby, 1930), and the preliminary geologic map by Rowley and others (1978).

The lower unit extends from the top of the Trout Creek Sandstone Member, and may possibly be from 1,700 to 2,100 feet (518 to 640 m) thick in this quadrangle. It consists of interbedded sandstone, siltstone, sandy shale, carbonaceous shale and coal beds. The sandstone is white to tan, light gray to brown, and fine to medium grained. Two coal groups, the Fairfield coal group and the Goff coal group, occur in the lower unit of the Williams Fork Formation (Hancock and Eby, 1930).

The Lion Canyon Sandstone Member is a thick-bedded light-yellow-brown sandstone, and may contain locally thin beds of shale and siltstone. It is estimated to be at least 100 feet (30 m) thick in this quadrangle.

The upper unit of the Williams Fork Formation, which may be a Lance equivalent (Pipiringos and Rosenlund, 1977), is probably between 1,200 and 1,600 feet (366 and 488 m) thick, consisting of a series of yellow to brown massive and shaly sandstone, brown to black sandy and carbonaceous shale, and coal beds. Coal beds in this unit that crop out above the Lion Canyon Sandstone Member have been designated the Lion Canyon coal group by Hancock and Eby (1930).

Unconformably overlying the Williams Fork Formation, the Fort Union Formation of Paleocene age crops out over a small area in the southwestern part of the quadrangle (Reheis, 1975; Rowley and others, 1978). In the White Rock quadrangle to the southeast, the formation is composed predominantly of light-gray to brown sandstone with minor amounts of interbedded siltstone, claystone, carbonaceous shale, and thin coal beds. Several conglomerate beds occur in the basal 40 to 70 feet (12 to 21 m) of the formation (Pipiringos and Rosenlund, 1977). The formation ranges in thickness from about 1,200 to 1,400 feet (366 to 427 m) on the surface in the White Rock quadrangle and may be even thicker in this quadrangle.

The Wasatch Formation of Eocene-Paleocene age also crops out over a small area in the southwestern part of the quadrangle (Sears, 1925; Rowley and others, 1978). The contact between the Wasatch and the underlying Fort Union strata is probably unconformable (Gale, 1907) in this area. In general, the Wasatch is composed of variegated shale, light-gray to tan sandstone with minor amounts of conglomerate, and it is estimated that its thickness may be about 1,200 feet (366 m) where exposed.

The Miocene-age Browns Park Formation unconformably overlies older formations over most of the quadrangle (Rowley and others, 1978). According to Sears (1925), the Browns Park is at least 1,200 feet (366 m) thick in northwestern Colorado, but its total thickness in this quadrangle is unknown. It consists primarily of chalky-white to yellowish-brown fine-grained tuffaceous sandstone with conglomerate beds at its base.

Holocene and Pleistocene deposits of stream alluvium cover the valleys of Deception Creek, Freeman Gulch, and Cedar Springs and Jacobs Draws. Eolian deposits cover a wide northeast-trending band across the quadrangle along Wild Horse Ridge.

The Cretaceous sedimentary rocks in the quadrangle accumulated close to the western edge of a Late Cretaceous epeirogenic seaway which covered part of the western interior of North America. A major regressive cycle caused the deposition of a series of marine, near-shore marine, and non-marine sediments in the Citadel Plateau area (Masters, 1959; Ryer, 1977).

The Mancos Shale was deposited in an offshore marine environment which existed east of the shifting strand line. Deposition of the Mancos Shale in the quadrangle area ended with the eastward migration of the shoreline and the subsequent deposition of the Iles Formation (Kucera, 1959).

The interbedded sandstone, shale, and coal of the Iles and Williams Fork Formations were deposited as a result of minor changes in the position of the shoreline. Near-shore marine, littoral, brackish tidal, brackish and fresh water supratidal, and fluvial environments existed during the deposition of the Iles and Williams Fork Formations in the area. The major sandstone members of the Iles and Williams Fork Formations, including the Trout Creek and Lion Canyon Sandstone Members, were deposited in shallow marine and near-shore marine environments as the shoreline fluctuated. Coal beds of limited areal extent, such as those in the Goff and Lion Canyon coal groups, were generally deposited in environments associated with fluvial systems, such as back-levee and coastal plain swamps, interchannel basin areas, and abandoned channels (O'Boyle, 1955; Konishi, 1959).

After the final withdrawal of the Cretaceous sea, thick sections of detrital material, eroded from older deposits, were deposited as the Fort Union Formation. The conglomerates, sandstones, shales, and coals were deposited in braided-stream, flood-plain and backswamp deposits (Beaumont, 1979).

The coarse sediments at the base of the Wasatch Formation were deposited in a fluvial environment and the upper sediments were deposited in alternating swamp, lake and stream environments (Beaumont, 1979).

The Browns Park Formation was deposited after a long period of non-deposition and erosion. It is a continental deposit consisting mostly of fluvial and eolian deposits, and much of its thickness has been removed as a result of late Cenozoic erosion.

Structure

The Danforth Hills KRCRA lies in the northern part of the Piceance structural basin of west-central Colorado. The Danforth Hills area is bordered on the northeast by the Axial Basin anticline, approximately 8 miles (13 km) southeast of the quadrangle, and on the west by the Yampa Plateau, approximately 8 miles (13 km) west of the quadrangle.

Reheis (1975) indicates that the beds within this quadrangle are situated on the southwestern limb of the northwest-trending Danforth Hills anticline and dip from approximately 25° to 50° southwest.

COAL GEOLOGY

Coal beds in the Fairfield, Goff, and Lion Canyon coal groups of the Williams Fork Formation have been identified in the northwest quarter of the Citadel Plateau 15-minute quadrangle. The Fairfield coal group includes all coal beds in the lower part of the Williams Fork Formation and the Goff coal group is applied to the coal-bearing strata that underlie the Lion Canyon Sandstone Member (Hancock and Eby, 1930). Coal beds of the Lion Canyon coal group occur in the upper Williams Fork Formation above the Lion Canyon Sandstone Member. Coal beds exceeding Reserve Base thickness (5 feet or 1.5 meters) are known to occur in both the Goff and Lion Canyon coal groups in this quadrangle, but not in the Fairfield coal group. The coal beds identified in this quadrangle have been given bracketed numbers for identification purposes in this quadrangle only (plates 1 and 3).

Chemical analyses of coal.--Chemical analyses were not available for coals from the Goff and Lion Canyon coal groups in this quadrangle. However, it is believed that these coals are similar in rank to coal from the Goff and Lion Canyon coal groups mined, respectively, at the James mine in the Ninemile Gap quadrangle to the southeast and at the Montgomery mine in the Meeker quadrangle to the southeast. Analyses of these coals are listed in table 1. In general, these coals are ranked as high-volatile C bituminous on a moist, mineral-matter-free basis according to ASTM Standard Specification D 388-77 (American Society for Testing and Materials, 1977).

Goff Coal Group

The Goff coal group is located below the Lion Canyon Sandstone Member in the upper part of the lower Williams Fork Formation. One coal bed greater than Reserve Base thickness, the Goff [1] coal bed, was encountered at only one location and has been treated as an isolated data point and is shown in figure 4. (All figures follow p. 13). In instances where single or isolated measurements of coal beds thicker than 5 feet 1.5 m) are encountered, such as that of the Goff [1] coal bed, the standard criteria for construction of isopach, structure contour, overburden isopach, and mining ratio maps are not available. The lack of data concerning this coal bed limits the extent to which it can be reasonably projected in any direction and precludes correlation with any other, better known coal beds.

Lion Canyon Coal Group

The Lion Canyon coal group occurs above the Lion Canyon Sandstone Member in the upper part of the Williams Fork Formation. One coal bed of Reserve Base thickness, the Lion Canyon [3] coal bed, was identified in the south-central part of the quadrangle where it is 5.0 feet (1.5 m) thick. The Lion Canyon [3] coal bed extends to the south into the adjacent southwest quarter of the Citadel Plateau quadrangle where it has a thickness of 6.0 feet (1.8 m) in sec. 21, T. 5 N., R. 96 W.

COAL RESOURCES

Data from outcrop measurements (Reheis, 1975) were used to construct outcrop, isopach, and structure contour maps of the Lion Canyon [3] coal bed in the northwest quarter of the Citadel Plateau 15-minute quadrangle.

Coal resources for Federal land were calculated using data obtained from the coal isopach map (figure 1) and the areal distribution and identified resources (ADIR) map (figure 3). The coal bed acreage (measured by planimeter), multiplied by the average isopached thickness of the coal bed and by a conversion factor of 1,800 short tons of coal per acre-foot (13,238 metric tons per hectare-meter) for bituminous coal, yields the coal resources in short tons of coal for each coal bed. Coal beds thicker than 5 feet (1.5 m) that lie less than 3,000 feet (914 m) below the ground surface are included. These criteria differ somewhat from those used in calculating Reserve and Reserve Base tonnages as stated in U.S. Geological Survey Bulletin 1450-B which calls for a minimum thickness of 28 inches (70 cm) and a maximum depth of 1,000 feet (305 m) for bituminous coal.

Reserve Base and Reserve tonnages for the Lion Canyon [3] coal bed are shown in figure 3, and are rounded to the nearest 10,000 short tons (9,072 metric tons). Only Reserve Base tonnages (designated as inferred resources) are calculated for the area influenced by the isolated data point (Goff [1] coal bed, figure 4).

Coal Reserve Base tonnages per Federal section are shown on plate 2 and total approximately 458,000 short tons (415,000 metric tons) for the entire quadrangle, including the tonnage from the isolated data point. Reserve Base tonnages in the various development potential categories for surface and subsurface mining methods are shown in tables 2 and 3. The source of each indexed data point shown on plate 1 is listed in table 4.

Dames & Moore has not made any determination of economic recoverability for any of the coal beds described in this report.

COAL DEVELOPMENT POTENTIAL

Coal development potential areas are drawn to coincide with the boundaries of the smallest legal land subdivisions shown on plate 2. In sections or parts of sections where no land subdivisions have been surveyed by the BLM, approximate 40-acre (16-ha) parcels have been used to show the limits of the high, moderate, or low development potentials. A constraint imposed by the BLM specifies that the highest development potential affecting any part of a 40-acre (16-ha) lot, tract, or parcel be applied to that entire lot, tract, or parcel. For example, if 5 acres (2 ha) within a parcel meet criteria for a high development potential; 25 acres (10 ha), a moderate development potential; and 10 acres (4 ha), a low development potential; then the entire 40 acres (16 ha) are assigned a high development potential.

Development Potential for Surface Mining Methods

Areas where the coal beds of Reserve Base thickness are overlain by 200 feet (61 m) or less of overburden are considered to have potential for surface mining and can be assigned a high, moderate, or low development potential based on the mining ratio (cubic yards of overburden per ton of recoverable coal). The formula used to calculate mining ratios for surface mining of coal is shown below:

$$MR = \frac{t_o\,(cf)}{t_c\,(rf)}$$

where MR = mining ratio

t_o = thickness of overburden in feet

t_c = thickness of coal in feet

rf = recovery factor (85 percent for this quadrangle)

cf = conversion factor to yield MR value in terms of cubic yards of overburden per short tons of recoverable coal:
0.911 for subbituminous coal
0.896 for bituminous coal

Note: To convert mining ratio to cubic meters of overburden per metric ton of recoverable coal, multiply MR by 0.8428.

Areas of high, moderate, and low development potential for surface mining methods are defined as areas underlain by coal beds having respective mining-ratio values of 0 to 10, 10 to 15, and greater than 15. These mining ratio values for each development potential category are based on economic and technological criteria and were provided by the U.S. Geological Survey.

Unknown development potentials have been assigned to those areas where coal data is absent or extremely limited, including the area influenced by the isolated data point. Even though these areas may contain coal thicker than 5 feet (1.5 m), limited knowledge of the areal distribution, thickness, depth, and attitude of the coal beds prevents accurate evaluation of development potential in the high, moderate, and low categories. The area influenced by the isolated data point contains approximately 203,000 short tons (184,000 metric tons) of coal available for surface mining.

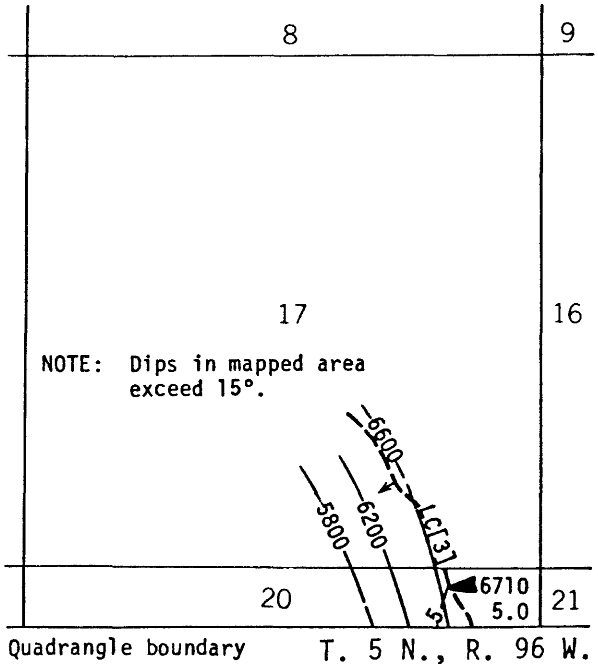
The coal development potential for surface mining methods is shown in figure 5. Of those Federal land areas having a known development potential for surface mining, all are rated as high. The remaining Federal lands within the KRCRA boundary are classified as having unknown development potential for surface mining methods.

Development Potential for Subsurface and In-Situ Mining Methods

Areas where the coal beds of Reserve Base thickness lie between 200 feet (61 m) and 3,000 feet (914 m) below the ground surface, having dips of 15° or less, are usually considered to have development potential for conventional subsurface mining methods. In this quadrangle, all known coal beds exceeding Reserve Base thickness have dips greater than 15°. Therefore, all Federal lands have been rated as having unknown development potential for conventional subsurface mining methods.

Unfaulted coal beds lying between 200 feet (61 m) and 3,000 feet (914 m) below the ground surface, dipping greater than 15°, are considered to have a development potential for in-situ mining methods. Based on criteria provided by the U.S. Geological Survey, coal beds of Reserve Base thickness dipping between 35° and 90° with a minimum Reserve Base of 70 million short tons (63.5 million metric tons) of subbituminous coal or 50 million short tons (45.4 million metric tons) of bituminous coal have a moderate potential for in-situ development. Coal beds dipping from 15° to 35°, regardless of tonnage, and coal beds dipping from 35° to 90° with less than 50 million short tons (45.4 million metric tons) of coal have a low development potential for in-situ mining methods. Coal lying between the 200-foot (61-m) overburden line and the outcrop are not included in the total coal tonnages available for in-situ mining because they are needed for cover and containment in the in-situ process.

Areas classified as having development potential for in-situ mining methods are shown in figure 6. Since the dips of the coal beds in these areas exceed 15° and the total Reserve Base tonnage is only 243,000 short tons (220,000 metric tons), all of the Federal land areas having a known development potential have been rated low for in-situ mining methods. The remaining Federal land areas within the KRCRA boundary have been classified as having an unknown development potential for in-situ mining methods.



EXPLANATION

———5———

ISOPACHS - Showing thickness of coal, in feet. Isopach interval 1 foot.

———6600——— — —

STRUCTURE CONTOURS - Drawn on top of coal bed. Solid where vertical accuracy within 40 feet; long dashed where vertical accuracy possibly not within 40 feet; short dashed where projected above ground surface. Contour interval 400 feet (122 m). Datum is mean sea level.

▲ 6710
5.0

POINT OF MEASUREMENT - Showing altitude of top of coal bed, and thickness of coal, in feet. Includes all points of measurement other than drill holes.

LC[3] - Lion Canyon Coal Group, coal bed [3]

COAL BED SYMBOL AND NAME - Coal bed identified by bracketed numbers is not formally named, but is numbered for identification purposes in this quadrangle only.

— — — — —LC[3]— — — — — —

TRACE OF COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Arrow points toward coal-bearing area. Short dashed where inferred by present authors.

To convert feet to meters, multiply feet by 0.3048.

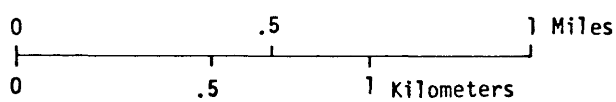
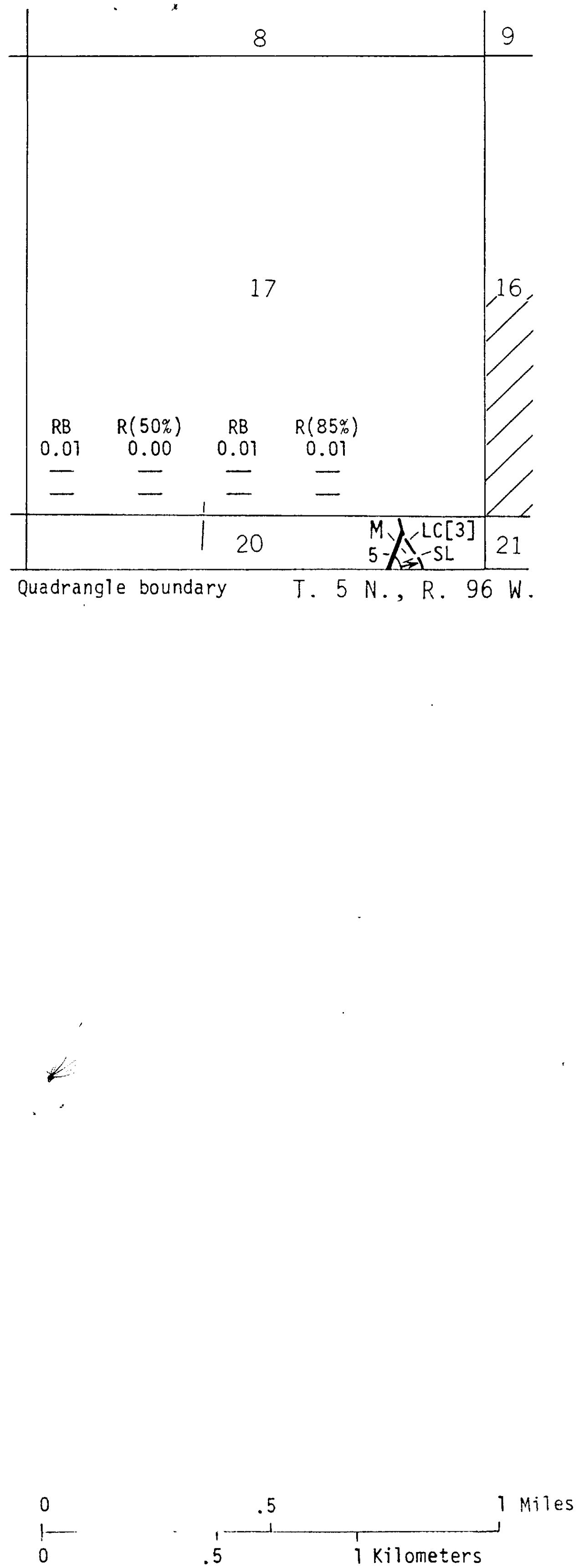


FIGURE 1. — Isopach and structure contour map of the Lion Canyon coal group.



EXPLANATION

NON-FEDERAL COAL LAND - Land for which the Federal Government does not own the coal rights.

——————5——————

ISOPACH - Showing thickness of coal, in feet.

LC[3] - Lion Canyon Coal Group, coal bed [3]

COAL BED SYMBOL AND NAME - Coal bed identified by bracketed numbers is not formally named, but is numbered for identification purposes in this quadrangle only.

– – – – – –LC[3]– – – – – –

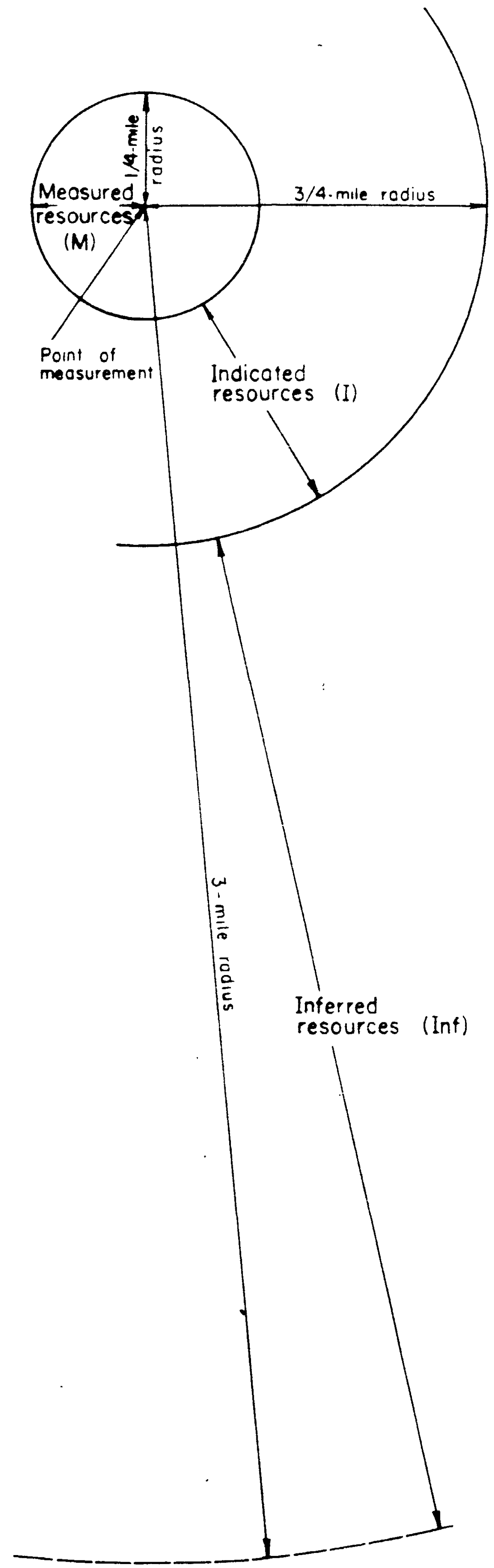
TRACE OF COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Short dashed where inferred by present authors.

——————SL——————

STRIPPING-LIMIT LINE - Boundary for surface mining (in this quadrangle, the 200-foot-overburden isopach). Arrow points toward the area suitable for surface mining where the recovery factor is 85 percent, and away from the area suitable for subsurface mining (down dip to the 3,000-foot-overburden isopach) where the recovery factor is 50 percent.

RB	R(85%)	RB	R(50%)	
0.01	0.01	0.01	0.00	(Measured)
—	—	—	—	(Indicated)
—	—	—	—	(Inferred)

IDENTIFIED COAL RESOURCES - Showing totals for Reserve Base (RB) and Reserves (R), in millions of short tons, for each section or part of section of non-leased Federal coal land, both within and beyond the stripping-limit line. Reserve (R) tonnage is calculated by multiplying the Reserve Base (RB) tonnage by the appropriate recovery factor. Dash indicates no resource in that category. Underground Reserves have been calculated for only that part of the Reserve Base that is suitable for underground mining, and do not include Reserves for areas where the dip of the coal bed exceeds 15°. Therefore, in some instances, underground Reserves may be less than 50 percent of the Reserve Base.



BOUNDARY LINES - Enclosing areas of measured (M), indicated (I), and inferred (Inf) coal resources.

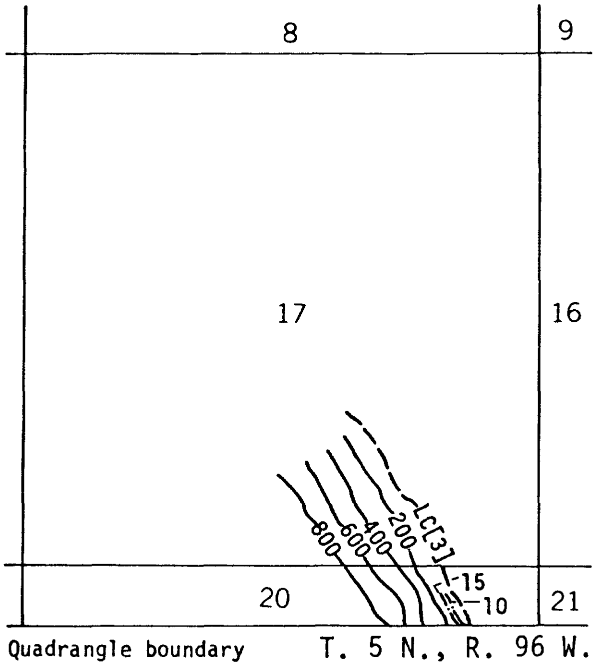
To convert short tons to metric tons, multiply short tons by 0.9072.

To convert feet to meters, multiply feet by 0.3048.

To convert miles to kilometers, multiply miles by 1.6093.

FIGURE 3. — Areal distribution and identified resources map of the Lion Canyon coal group.

1022



EXPLANATION

——200——

OVERBURDEN ISOPACHS - Showing thickness of overburden, in feet, from surface to top of coal bed. Isopach interval 200 feet (61 m) beyond the stripping-limit line.

——·——10——·——

MINING-RATIO CONTOUR - Number indicates cubic yards of overburden per ton of recoverable coal by surface mining methods. Contours shown only in areas underlain by coal of Reserve Base thickness within the stripping-limit (in this quadrangle, the 200-foot-overburden isopach). To convert mining ratio to cubic meters of overburden per metric ton of recoverable coal, multiply mining ratio by 0.8428.

LC[3] - Lion Canyon Coal Group, coal bed [3]

COAL BED SYMBOL AND NAME - Coal bed identified by bracketed numbers is not formally named, but is numbered for identification purposes in this quadrangle only.

– – – – – –LC[3]– – – – – –

TRACE OF COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Short dashed where inferred by present authors.

To convert feet to meters, multiply feet by 0.3048.

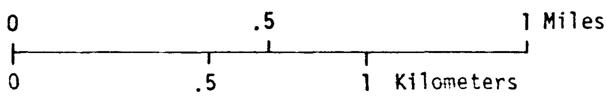
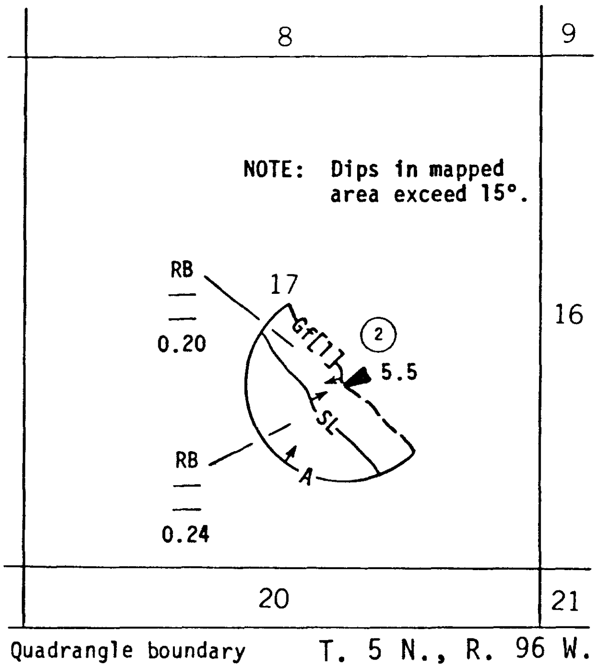


FIGURE 2. — Overburden isopach map of the Lion Canyon coal group.



EXPLANATION

▲ (2)
5.5

POINT OF MEASUREMENT - Showing thickness of coal, in feet. Includes all points of measurement other than drill holes. Index number refers to hole on plate 1 of CRO map or in table of text. Letters designate name of coal bed as listed below. Bracketed number identifies coal bed named on plates 1 or 3.

Gf[1] - Goff Coal Group, coal bed [1]

COAL BED SYMBOL AND NAME - Coal bed identified by bracketed numbers is not formally named, but is numbered for identification purposes in this quadrangle only.

---Gf[1]------

TRACE OF COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Arrow points toward coal-bearing area. Short dashed where inferred by present authors.

———SL———

STRIPPING-LIMIT LINE - Boundary for surface mining (in this quadrangle, the 200-foot-overburden isopach). Arrow points toward area suitable for surface mining.

———A———

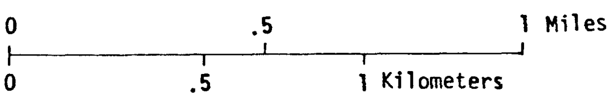
BOUNDARY OF IDENTIFIED RESERVE BASE COAL - Drawn along the coal bed outcrop and an arc (A) drawn 1,000 feet from the nearest point of Reserve Base coal bed measurement. Arrow points toward area of identified Reserve Base coal.

RB
— (Measured)
— (Indicated)
0.20 (Inferred)

IDENTIFIED COAL RESOURCES - Showing totals for Reserve Base (RB), in millions of short tons, for each section or part(s) of section of non-leased Federal coal land, either within or beyond the stripping-limit. Dash indicates no resources in that category.

To convert short tons to metric tons, multiply short tons by 0.9072.

To convert feet to meters, multiply feet by 0.3048.



SCALE - 1:24,000 (1 inch = 2,000 feet)

FIGURE 4. — Areal distribution and identified resources map of non-isopached coal beds.

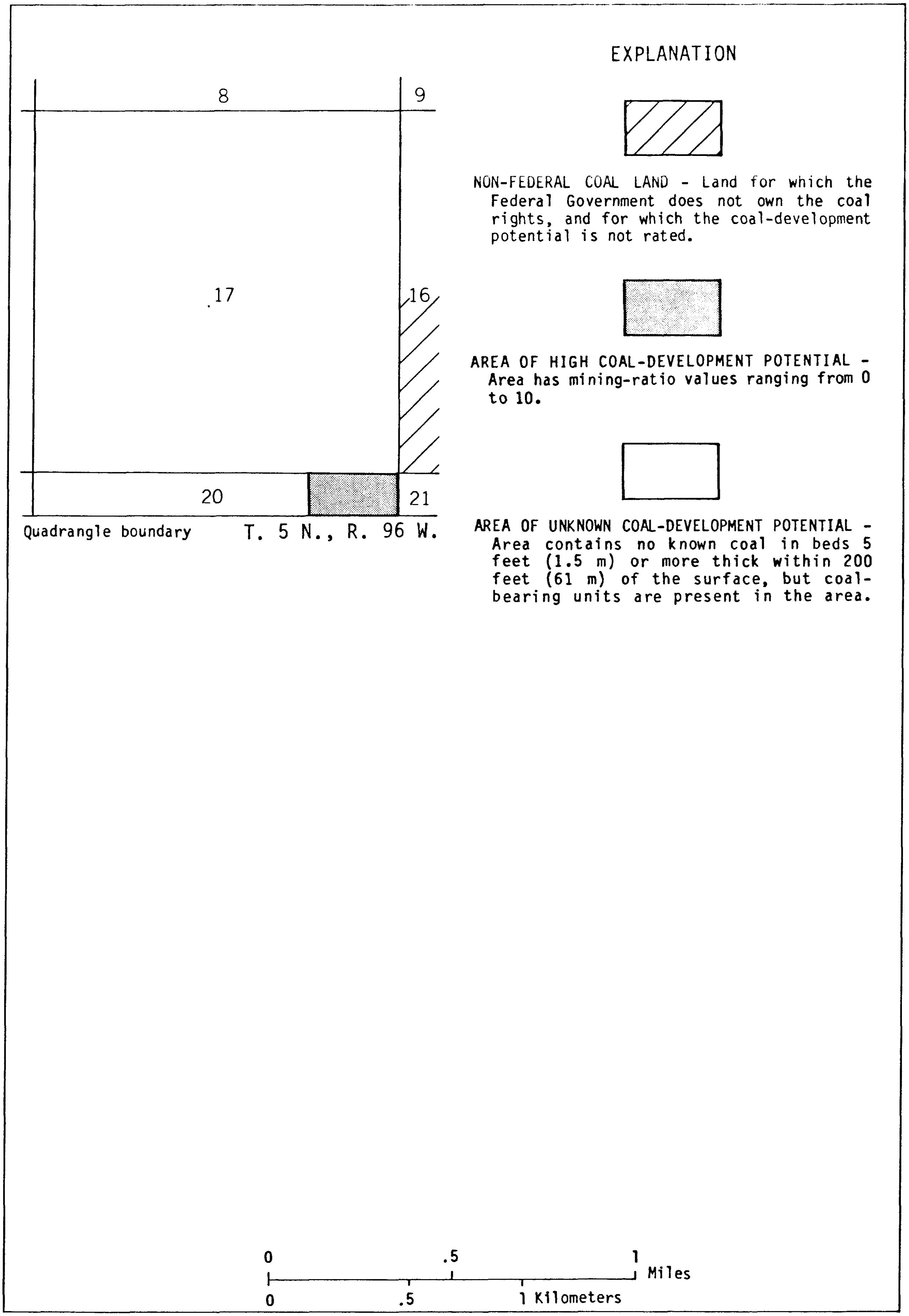


FIGURE 5. — Coal development potential map for surface mining methods.

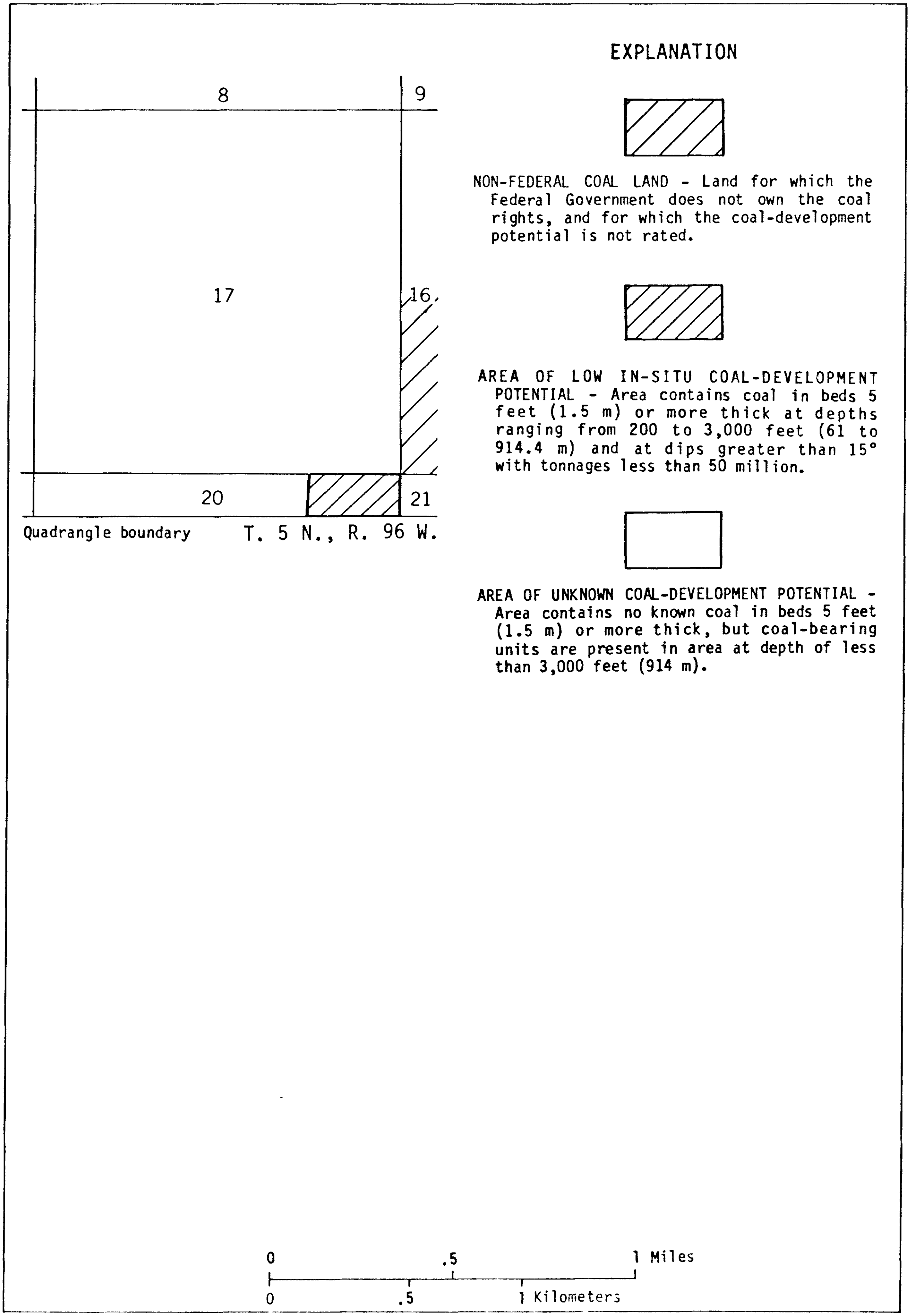


FIGURE 6. — Coal development potential map for in-situ mining methods.

Table 1. -- Chemical analyses of coals in the northwest quarter of the Citadel Plateau 15-minute quadrangle, Moffat County, Colorado.

Location	Coal Group Name	Form of Analysis	Proximate				Ultimate					Heating Value	
			Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu/Lb
NW¼, sec. 14, T. 3 N., R. 93 W., James Mine (George and others, 1937) from Ninemile Gap quadrangle	Goff	A	12.1	35.8	47.5	4.6	0.5	5.4	63.9	1.4	24.2	6,311	11,360
		C	-	40.7	54.0	5.3	0.6	4.7	72.6	1.5	15.3	7,172	12,910
		D	-	43.0	57.0	-	0.6	4.7	76.6	1.6	16.3	7,572	13,630
NW¼, sec. 29, T. 1 N., R. 94 W., Montgomery Mine (Hancock and Eby, 1930) from Meeker quadrangle	Lion Canyon	A	12.4	38.6	42.9	6.1	0.71	5.38	62.61	1.33	23.84	5,995	10,790
		B	10.6	39.4	43.7	6.3	0.72	5.27	63.89	1.36	22.50	6,115	11,010
		C	-	44.1	48.9	7.0	0.81	4.58	71.45	1.52	14.64	6,840	12,320
		D	-	47.4	52.6	-	0.87	4.92	76.83	1.63	15.75	7,355	13,240

Form of Analysis: A, as received
B, air dried
C, moisture free
D, moisture and ash free

Note: To convert Btu/pound to kilojoules/kilogram, multiply by 2.326

Table 2. -- Coal Reserve Base data for surface mining methods for Federal coal lands (in short tons) in the northwest quarter of the Citadel Plateau 15-minute quadrangle, Moffat County, Colorado.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Lion Canyon {3}	3,000	4,000	5,000	-	12,000
Isolated Data Point	-	-	-	203,000	203,000
Totals	3,000	4,000	5,000	203,000	215,000

NOTE: To convert short tons to metric tons, multiply by 0.9072.

Table 3. -- Coal Reserve Base data for in-situ mining methods for Federal coal lands (in short tons) in the northwest quarter of the Citadel Plateau 15-minute quadrangle, Moffat County, Colorado.

Coal Bed	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Lion Canyon {3}	-	6,000	-	6,000
Isolated Data Point	-	-	237,000	237,000
Totals	-	6,000	237,000	243,000

NOTE: To convert short tons to metric tons, multiply by 0.9072.

Table 4 -- Sources of data used on plate 1

Plate 1 Index Number	Source	Data Base
1	Reheis, M. J., compiler, 1975, Danforth Hills Known Coal Leasing Area: U.S. Geological Survey, unpublished map	Measured Section
2	↓	Measured Section
3	↓	Measured Section

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